JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 29 DECEMBER 15, 1939 NO. 12

BOTANY.—*Four southwestern subspecies of* Phlox.[1] EDGAR T. WHERRY, University of Pennsylvania.

Study of the Phloxes of Arizona in the preparation of a treatment of the genus in Dr. T. H. Kearney's forthcoming flora of that State has indicated the occurrence there of four plants that seem best regarded as subspecies but have never been assigned to that status. In the present note these are formally described and named.

Phlox diffusa Bentham[2]

This species has already been divided into two subspecies, *longistylis* Wherry[3] of British Columbia to northern Oregon, and *typica* Wherry[3] of southern Oregon to south-central California. A third subspecies has now been found to occur on mountains and plateaus of the Great Basin region and may be known as:

Phlox diffusa subcarinata Wherry, subsp. nov. Fig. 1

Clumps averaging 7 cm high, with the densely leafy shoots 4 cm long. Deep-green linear-subulate leaves averaging 10 mm long and 1.25 mm wide, surficially glabrous or sparse pubescent, basally ciliate. Cyme of 1 to 3 flowers on pedicels 1 (rarely 2 or 3) mm long. Sepals averaging 9 mm long, united for one-half to two-thirds their length into a tube, with somewhat carinate intercostal membranes, sometimes glabrous but usually basally pubescent, often more densely so than in the other two subspecies. Corollas white to lavender, the tube averaging 11 and lobes 7 mm long. Styles 3 to 6 or rarely 7 mm long, united to within 1 mm of the tips.

P. diffusa typica similis sed compactior; calycis membranis intercostalis subcarinatis.

Type.—In herbarium of Academy of Natural Sciences of Philadelphia, from Mount Rose, Washoe County, Nev., *Heller* 9910a, July 29, 1909. A sketch of one of the plants on the type sheet is reproduced herewith.

Range.—Washington and Idaho to California and Arizona, chiefly at altitudes of 5,000 to 10,000 feet in the Great Basin, and rarely in the Sierras. Localities represented in the larger eastern herbaria:

WASHINTON: Mount Spokane (n. limit, lat. 47° 53′), Tumwater Mountain, Klickitat Hills.

[1] Received August 28, 1939.
[2] Pl. Hartw.: 325. 1849.
[3] Proc. Acad. Nat. Sci. Philadelphia 90: 139. 1938.

OREGON: Maupin, Strawberry Lake, Crane Mountain.
IDAHO: Brundage Mountain.
CALIFORNIA: Bray, Mount Shasta, Truckee, Pine City, Mount Kaiser, Mineral King, Mount Pinos (s. limit, lat. 34° 48′).
NEVADA: Mount Rose, Franktown, Carson City, Kings Canyon.
UTAH: Virgin River Valley.
ARIZONA: Jacobs Lake and points southward, north rim of Grand Canyon.

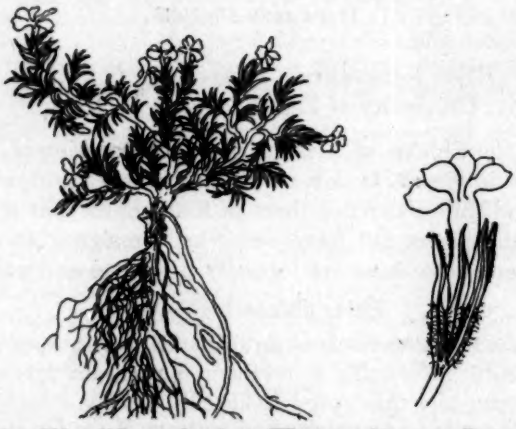

Fig. 1.—*Phlox diffusa subcarinata* Wherry, subsp. nov. Drawn by Miss Inez Renninger.

Phlox austromontana Coville[4]

The acerose-leaved plant with markedly carinate calyx-membranes to which this name was originally applied has short-decumbent or erect stems forming a compact clump, its longest leaves 12 to 20 mm, its corolla-tube 8 to 14 mm, and its styles 2.5 to 5 mm in length. The subspecies represented may be known as *P. austromontana* **vera** Wherry, nomen novum.

A variant of the species with long-decumbent stems forming an open clump, longest leaves 15 to 30, corolla-tube 12 to 18 mm, and styles 4.5 to 6 mm in length has been named by E. Nelson[5] var. *prostrata*. Its differences from the original subspecies are so marked, however, that it is here raised to subspecies rank: *P. austromortana* **prostrata** (E. Nelson) Wherry, status novus.

In his monograph of the genus, Brand[6] segregated from *P. austromontana* a supposedly distinct species, which he named *P. densa*. He noted that this had the aspect of an alpine form of the earlier species but considered its longer style to be distinctive. Study of a series of specimens of both indicates

[4] Contr. U. S. Nat. Herb. 4: 151. 1893.
[5] Rev. W. N. Amer. Phlox: 19. 1899. Also named *Phlox acerba* by A. Nelson, Amer. Journ. Bot. 25: 114. 1938.
[6] Engl. Pflanzenr. IV. 250: 83. 1907.

that no correlation exists between style-length and any other character, and as extensive intergradation is shown the two can scarcely be maintained as independent. The plant with especially compact habit, longest leaves 8 to 12 mm, corolla-tube 8 to 14 mm, and styles 3 to 6 mm in length is therefore here made a subspecies: *P. austromontana* **densa** (Brand) Wherry, status novus.

All three of these subspecies were first described from southwestern Utah; subsp. *vera* is now known to occur in all the Western States south of lat. 45°. Subsp. *prostrata* extends to southern California, where it is especially frequent, and to southeastern Arizona. Subsp. *densa* apparently occurs only from west-central Utah to middle Arizona.

ZOOLOGY.—*Observations on the distribution and ecology of the oribatid mites.*[1] WENDELL H. KRULL, U. S. Bureau of Animal Industry.

The oribatid mites have been incriminated only recently as intermediate hosts of economically important tapeworms of livestock. Stunkard (1937) reported recovering from experimentally infected mites, *Galumna* sp., cysticercoids of the common sheep tapeworm, *Moniezia expansa*. Later Stunkard (1939) reported in detail the experiments leading to this discovery and noted that "all the mites used fall within the generic concept of *Galumna*." He did not, however, identify definitely the infected mites as to species. Stunkard's work has subsequently been confirmed by Stoll (1938) and by the writer (Krull, 1939). Stoll reported infecting two kinds of mites, *Galumna* sp. and *Galumna nigra* (Ewing), by feeding to these arthropods eggs of *Moniezia expansa*, while the writer recovered infective cysticercoids of this tapeworm from mites, *G. emarginata* (Banks), which had been collected on pastures. The cysticercoids collected by the writer were administered to a tapeworm-free lamb, and specimens of *M. expansa* were recovered from this host animal at necropsy.

Although extensive studies on the oribatid mites have been published by Michael (1884, 1898), Banks (1915), Ewing (1917), and Jacot (1937), very little is known of their distribution and ecology. In order to obtain information on these points, which is needed before control measures for the anoplocephaline tapeworms of livestock can be formulated, a preliminary investigation was undertaken to determine under what conditions these mites occur, and the influence of climatic and other factors on their distribution and abundance. The results of this investigation are given herein. Some preliminary observations on the food habits of these mites and attempts to culture them are also included.

[1] Received June 27, 1939.

METHOD OF COLLECTING ORIBATID MITES

Conventional methods of collecting free-living mites were of limited value because in this study mites were required in large numbers, and from grass collected under all weather conditions, therefore, the following method was devised: Grass from which oribatid mites were to be collected was cut with ordinary grass shears and transferred in buckets to the laboratory. The grass was then washed immediately by transferring it, not over one pound at a time, to a parallel-sided glass jar, having a capacity of about 14 liters. The jar was filled to within several inches of the top with tap water having a temperature of not more than 60° F. The grass was plunged up and down several times in the water, then removed, a small amount at a time, after it had been agitated again in the water to remove any mites that might have remained attached. When all the grass had been removed, the washings were poured into a similar container through a screen having 34 meshes to the linear inch. The jar in which the grass had been washed was rinsed with water of the same temperature at least once and the washings poured through the screen, care being taken to cover most of the screen surface in order to remove any remaining mites. While the contents of the jar settled, the surface was examined for mites and any that appeared there were removed. After 2 or 3 minutes the water, except for 1 to 2 liters, was very carefully and quickly decanted. The remaining portion with the sediment was agitated and transferred to a 4-liter battery jar. The larger jar was rinsed with enough cold water to fill completely the smaller jar to within about an inch of the top. During sedimentation the surface of the water was examined again for mites, and any that were present were removed. As soon as the solid contents had settled the water was carefully and quickly decanted, leaving in the jar about 150 cc, which, after being agitated, was transferred to a 250-cc cone-shaped graduate, filling it to near the top. After the contents had settled and any mites coming to the surface had been removed, about 200 cc of the water was very carefully decanted and replaced by water having a temperature of 113° F. The addition of warm water changed the density of the medium and forced the mites to the surface and through the film formed by the surface tension so that they could be removed. For this procedure two teasing needles were held crossed and close together near the mites. When the needles were raised slowly the mite or mites adhered to one of the two needles. By touching the needle with the mite to a drop of water in the center of a watchglass the mite was released and would slide down the film

formed by the surface tension to the edge of the drop, where it became imprisoned. When all the mites had been transferred to the drop and while under observation through a binocular microscope they were drawn to one side and out of the drop with a teasing needle. The drop of water was then removed with a pipette. As soon as the water around the mites dried, one part of a gelatin capsule was slipped over them and while this was held in place the dish was inverted to transfer the mites; the remaining part of the capsule was then replaced. The mites were retained in the closed capsule until needed.

Though this method may appear somewhat unwieldy and unpractical, it will be found after a little practice to be quite efficient. However, certain details must be observed in order to obtain satisfactory results. In collecting the grass care must be taken to prevent loss of mites through undue disturbance, especially when the grass is dry. It is best to carry the washing process to its completion in the least possible time to prevent loss of mites. When the washings are sedimenting in the larger jar immediately after being screened, it is only rarely that a mite will be found on the surface. However, while the material is in the smaller jar a few of the mites may come to the surface, and these should be removed immediately. The number of mites coming to the surface in the smaller jar is usually an index to the final count, since 3 to 5 percent of the mites for each pound of grass seem to appear on the surface at this time. A few mites may be found on the surface of the cold water in the small graduate, but the limited surface makes it easy to remove them quickly. When the water at higher temperature is added, the majority of mites come to the surface; this has been verified by examination of the debris. To make sure that the mites were not imprisoned in the debris, the contents of the cone were agitated several times with a steel knitting needle.

Oribatid mites on the surface of the water are very distinctive in appearance and resemble tiny black or brown glistening pearls. It is only rarely that enough debris, including various organisms, comes to the surface to interfere seriously with the removal of the mites; should this happen, jarring the container or agitating the surface slightly with a needle will cause the debris to sink.

The heat of the water does not destroy the mites, although sometimes it seems to reduce their vitality. If it is desired to keep the mites alive for some time, the hot water should be omitted, leaving the cold water in the graduate. As the water temperature increases, the mites rise slowly and continue to rise for periods up to 3 hours.

Any attempt to shorten the process by omitting the second or battery-jar stage of washing, which involves decanting enough water from the large container to transfer the remaining contents directly to the small graduate, will lead to unsatisfactory results.

In order to obtain the maximum number of mites from grass from a given area, the samples should be collected in the morning following a rain sufficient to saturate the ground. The grass at the time collected should be only slightly moist, the day cloudy, and the collection made as soon after daylight as possible. When the number of mites per pound of grass is large, it is well to wash the grass a second time in order to obtain the maximum number present.

OBSERVATIONS ON THE ECOLOGY OF ORIBATID MITES

The data so far obtained are based on the study of mites from October 18, 1937, to May 27, 1938. The conclusions relative to abundance, distribution, and conditions affecting the mites were reached from a study of the mites collected from 359 samples representing a total of 618 pounds of grass. The samples varied in weight from 1 ounce to 3 pounds, with an occasional larger sample; these samples were collected from 12 stations at the Agricultural Research Center, Beltsville, Md. A total of 18,238 oribatid mites were recovered from the grass collected and examined; this represented an average of about 30 mites per pound of grass.

The following species of mites[2] were collected: *Dameosoma minuta* Ewing, *Galumna curva* (Ewing), *G. emarginata* (Banks), *G. minuta* (Ewing), *G. rugosala* (Ewing), *Notaspis spinipes* (Banks), *Oribatula minuta* (Ewing), *Oripoda elongata* Banks and Perg., *Phthiracarus americanus* Ewing, *Zygaribatula clavata* (Ewing), unidentified species of *Ceratozetes*, *Fuscozetes*, *Galumna*, *Liebstadia*, *Neoribates*, *Oribatella*, *Pelops*, *Scheloribates*, *Sphaerobates*, and *Zygaribatula*, and new species in at least two new genera. The species collected from an old, permanent, open sheep pasture were *Galumna emarginata* (Banks), *G. minuta* Ewing, *Galumna* sp., *Oribatula minuta* (Ewing), *Oribatula* sp., *Pelops* sp., *Scheloribates* sp., and *Sphaerobates* sp.

Factors affecting distribution of oribatid mites.—The mites in the area studied were rather general in distribution, and an occasional one could be found almost anywhere, even in areas that were quite barren. In certain grassy areas, however, which, judged from all known data concerning their habitat, should have had mites in

[2] The identifications were made by Dr. H. E. Ewing, of the U. S. Bureau of Entomology and Plant Quarantine.

abundance, these arthropods were found only with difficulty. The mites were more apt to be found in abundance and retained the greatest constancy in areas where moisture was plentiful enough to prevent limitation of the growth of grass.

The mites were found in considerable numbers under almost any pasture condition. In open pastures having only occasional deciduous trees, the shaded areas did not influence to any extent the distribution of the mites, except that during the winter months a few more mites were always collected from around the isolated trees. The mites were much more apt to be abundant in pastures shaded by coniferous trees, where the organisms were protected throughout the year from the effects of sudden and excessive changes of environmental conditions. In the area studied the mites were most abundant in a heavily shaded flat pasture surrounded by coniferous and deciduous trees and containing grass of a soft texture and about 6 inches high. The mites were not reduced excessively by prolonged cold wet weather of a week's duration or by a prolonged dry spell of a month, if these changes occurred during spring and early summer.

The relative number of mites found on the grass in a given location varied tremendously with conditions of environment, the influence of some factors having been ascertained. Those factors that have been more or less definitely established as influencing the vertical distribution of the mites are water, light, wind, and food.

The mites seem to have a very delicate adjustment to water, and succumb readily at room temperature if they are not protected from evaporation; they may be floated on water, without taking food, for at least 18 hours. In their native habitat the mites apparently maintain their relationship to proper moisture conditions by their movements in and on the ground and on the grass, and in this respect they have considerable latitude with regard to moisture, as well as to other conditions. The proportion of mites on the grass in a given area apparently depends to a large extent on moisture conditions. They were the most abundant the day after a heavy rain sufficient to saturate the ground thoroughly, and this was found to be the only time that an estimate could be obtained from grass samples of the number of mites in any location. Since the mites respond negatively to excessive moisture, it may be assumed that their presence in large numbers in the grass after heavy rains is an attempt on the part of the mite to escape this moisture. In accordance with this response it has been found that light rains, heavy fogs, and dew do not change materially the distribution of the mites, and of these conditions the light rains

affect them most. Their response to snow was not studied, but it was possible always to collect them from grass covered with snow.

The mites avoid excessive light, and on clear days very few if any could be collected from grass; they were most abundant immediately after daybreak. On cloudy days they remained somewhat more numerous and constant throughout the day. They appear to leave the grass when there is a high wind. The number of mites on the grass increased immediately when a cloudy day with light rains succeeded a period of 2 or 3 days without rain.

Just what effect temperature has on the mites has not been definitely determined, but from the observations made it seems to have little or no effect. As previously mentioned, mites were collected from grass cut in snow; moreover, they were as abundant on grass at a temperature of 20° F., the lowest encountered during the period covered, as they were at higher temperatures.

Seasonal distribution.—The mites were found to be much more abundant in spring than in winter, and there is a very sudden and striking increase in numbers when the new spring growth of grass is about 3 inches tall. It is possible that a part of this increase in mites is the result of the accumulation of eggs and young during the winter months, when periods of warm weather are not of sufficient duration to allow the mites to mature but are long enough for the adults to feed and lay eggs. The relative number of mites present during fall and winter as compared with the number present in spring after the new growth of grass appears may be deduced roughly from the following data: From 406 pounds of grass collected from October 18 to March 17, a total of 4,898 mites were obtained, whereas 13,340 mites were recovered from 212 pounds collected from March 18 to May 27. From 226 pounds of grass collected in a sheep pasture from October 18 to March 17, 1,821 mites were recovered as compared with 59 pounds of grass collected in the same pasture from March 18 to May 27, which yielded 4,527 mites.

Prevalence of mites on grass.—On the basis of the data so far obtained, it appears that the actual number of mites on grass varies considerably, and that there are times, even in spring, when no mites can be recovered. The largest number of mites per pound of grass recovered from an open sheep pasture was 619; these were obtained from 15 ounces of grass taken on May 20. The largest number prior to the time of the spring growth of grass was 100 per pound, which were obtained from a 2½-pound sample collected on February 18.

The largest number per pound of grass was from samples taken

from a shaded pasture, where 2,547 mites were obtained from 2 pounds of grass collected at 9 a. m. on May 19. From this same pasture 1,158 were taken from 1 pound 10 ounces of grass at 11 a. m. on March 31. Because of excessive grazing, not enough collections were made prior to the time that the spring growth appeared to give a comparison. In an area frequented by wild rabbits, on the edge of a pond, the largest number of mites per pound of grass was 325 from a 1 pound 4 ounce sample collected at 9 a. m. on March 18; the largest number prior to the spring growth of grass was 187 from 1 pound 4 ounces of grass taken on October 29.

Under ordinary dry conditions, beginning on the fourth day after a rain, it was unusual to find the mites in greater abundance than 5 per pound of grass after 9 a. m. The variation in the numbers of mites present in a given area on different, yet not widely separated, days is shown by the following data: From a collection of 1 pound 13 ounces of grass taken at 8 a. m. on May 16, 168 mites were obtained. In the same area a collection of 1 pound 4 ounces of grass taken at 9 a. m. on March 28 yielded 12 mites, whereas 1 pound 10 ounces of grass collected at 11 a. m. on March 31 yielded 1,158 mites.

Response to artificial change of conditions.—After the abundance and distribution of the mites in a pasture had been ascertained, certain selected portions were fenced. These areas were used for the purpose of encouraging the multiplication and growth of the mites. Pellets from two sheep contaminated with eggs of *Moniezia expansa* were spread on the areas during fall and winter months. This ground was never without water for more than 3 days; in the event that rain did not fall in the allotted time the ground was sprinkled. In the spring the excess debris was raked off and the areas were kept free from weeds. Grass samples from which the mites were collected were taken throughout the period of investigation, and during that time a few mites, rarely in excess of the general average, could always be collected. The record number per pound of grass, 115 mites, was taken from a 1 pound 10 ounce sample collected on April 15. The interesting fact about these areas was that the mites did not respond to this kind of treatment, as indicated by the small number collected from the grass samples. The reason for this indifferent response is not apparent.

After it had been determined that the maximum number of mites on grass could be collected after rains extensive enough to saturate the ground, it was assumed that the same results could be obtained by sprinkling areas and cutting the grass the following day. However, the results were not as anticipated. Usually the sprinkling increased

slightly the number of mites on the grass, the maximum results achieved comparing favorably with those following light rains.

Relative abundance of species.—Beginning in March mites were separated into several distinguishable types, some of which represented distinct species; consequently, comparisons as to abundance and distribution can be given. The total number of mites collected and separated from all localities studied was 11,310, and of these 568 were *Galumna emarginata*, which had been determined by the writer (Krull, 1939) to be an intermediate host of the sheep tapeworm, *Moniezia expansa*.[3] The mite was found to be generally distributed, having been collected at all seasons studied; however, it was more variable as to relative numbers when compared to the rest of the mites. These mites were most abundant during April and May, and at this time more abundant in an open pasture than in one that was heavily shaded. In an open pasture in which there was a single deciduous tree, the mites were most numerous during fall and winter in the grass around the tree than in the rest of the pasture; in spring the conditions were reversed. During the winter months this mite was found to be commonest on an area near a pond where moisture conditions were the most constant of any area studied. In spring the mites were the most numerous in an open, low-lying, flat, undergrazed pasture in which the grass was rather high. *Galumna emarginata* was rarely more abundant than 5 per pound of grass at any time or in any plot, although in one exceptional case 89 were taken from 15 ounces of grass collected on May 20 from the low-lying pasture.

Galumna minuta was the commonest mite found, and of the 11,310 mites already mentioned 7,270 were of this species. This species was generally distributed and was collected from all stations in all seasons studied.

Nymphs of oribatid mites could be found at all seasons but were commonest during the last week in March and during the last week in May.

[3] During April and May, 286 specimens of *Galumna emarginata* collected from pastures contaminated with eggs of *M. expansa* were dissected and examined for larval tapeworms. Five were found to be infested, each containing one fully developed cysticercoid; one of the mites had, in addition, two undeveloped cysticercoids that had attained nearly maximum size. One other mite collected in November contained a fully developed larva. Four of the 5 cysticercoids were measured without pressure in water and averaged 178μ long by 147μ wide, the largest being 200μ by 150μ and the smallest 160μ by 145μ. During the same months 2,606 specimens of *G. minuta* were examined for cysticercoids and all were negative. Of the other species of oribatid mites, 623 were examined and all were negative.

OBSERVATIONS ON THE FOOD HABITS OF ORIBATID MITES

The oribatid mites in general eat hyphae and spores of fungi, debris, anoplocephaline tapeworm eggs, and cellular material of blades of dead grass in certain stages of decomposition. They exhibit considerable choice as to the fungi they eat, devouring only certain of the white fungi and their black spores, ignoring completely any in which the hyphae are colored. The fungi are eaten in a moist or dry state. The mites have gluttonous appetites and devour an enormous amount of material. In feeding them eggs of the tapeworm *M. expansa*, it was found the debris surrounding the eggs as well as the eggs was desired as food. Eggs that were moist were not accessible to the mites and were merely pushed around by them. Eggs that were accessible had to be well anchored and apparently dry. Since the mouth parts of the mites are such as to prevent the ingestion of the egg in its entirety, the mites gain entrance to the eggs by making a hole in the outer dry membranes and ingest the contents which are freed in this manner. The remaining parts of the membranes are usually ignored. Mites have been observed to work for considerable periods of time before succeeding in making an opening in an egg. The observations concerning the reactions of the mites to tapeworm eggs may be easily demonstrated by applying eggs to pieces of agar dispersions which are dried and placed in a container where the mites have access to them.

CULTURING ORIBATID MITES

Attempts were made to culture the various oribatid mites in covered stender dishes of several sizes and in various larger containers. For substratum substances soil, sand, paper, filter paper, and agar dispersions have been used, and pebbles, grass leaves, decaying plant material, and pieces of agar and paper have been employed to give them retreats and cover. Fungi in addition to those transferred accidentally to the habitat were supplied on pieces of grass leaves and pieces of agar. Numerous mites have been raised in this way, but no method has been found that could be depended on to give consistent results. The number of nymphs sometimes appearing in an experimental habitat was exceedingly large in view of the number of adults supplied for stock and the small number of eggs carried by the mites at one time.

The individual species varied considerably in their response to artificial culture. Species of the genus *Galumna* were the most difficult

to handle. *G. minuta* was raised to maturity in several cultures. *G. emarginata* although the largest and most robust mite encountered was the most difficult to handle and could be kept at most only a couple of weeks. Nymphs of *G. emarginata* hatched under artificial conditions lived only a few days.

SUMMARY

A method for collecting oribatid mites under all weather conditions has been described.

Oribatid mites in the region studied were most abundant on grass after rains sufficient to saturate the ground, and they retained their greatest constancy in areas where moisture was plentiful enough to prevent limitation of the growth of grass. Numerous mites of the various species recorded could be collected from sheep pastures. Water, light, wind, and food are factors that were found to be important in influencing the vertical distribution of the mites on grass. A striking increase in the number of mites on grass was observed at the time the spring growth of grass was 3 inches tall. Mites kept under controlled conditions ate hyphae and spores of fungi, debris, cellular material of blades of dead grass, and anoplocephaline tapeworm eggs.

Numerous mites of the various species recorded were dissected and examined for cysticercoids of *Moniezia expansa*, which were found only in *Galumna emarginata*. This mite was generally distributed, could be collected at all seasons during which the investigation was in progress, and was taken only rarely in greater numbers than 5 per pound of grass.

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ENTOMOLOGY.—*Revision of the genus* Ceratagallia *Kirkaldy (Homoptera: Cicadellidae).*[1] P. W. OMAN, U. S. Bureau of Entomology and Plant Quarantine.

The monobasic genus *Ceratagallia* was established by Kirkaldy[2] for *Agallia bigeloviae* Baker. Because the name was published without a formal description, subsequent authors have considered it a *nomen nudum.* However, the inclusion of the previously described species, *bigeloviae* Baker, satisfies the requirements of the International Rules of Zoological Nomenclature, and *Ceratagallia* is available for the species treated in this paper. Attention is called to the fact that *Ceratagallia* Kirkaldy is an older name than *Aceratagallia* Kirkaldy,[3] although the latter name appeared in Bulletin 3 and the former in Bulletin 4.

Ceratagallia and *Aceratagallia* may be distinguished from other North American agallian leafhoppers by the character of the pronotum, which is transversely striated, and the styles of the male genitalia, which are not forked. In addition, the nymphs are without cephalic processes. *Ceratagallia* is differentiated from *Aceratagallia* by the 4-lobed posterior margin of the seventh sternite of the female and the V-shaped aedeagus of the male. The males may usually be recognized also by the shape of the plates, which are usually about 2 to 2½ times as long as their combined basal width and have the lateral and distal margins turned strongly upward, thus forming a trough-shaped cavity in which lie the distal extremities of the styles. Representatives of typical *Aceratagallia* are widely distributed in the Nearctic region, whereas the species of *Ceratagallia* are confined to the semiarid portions of the United States and adjacent Mexico. Representatives of the latter genus are at hand from Lower California, California, Arizona, Nevada, Utah, Idaho, Colorado, New Mexico, Texas, and Kansas.

Ceratagallia includes the species treated by the writer[4] in 1933 as the *bigeloviae* group of the genus *Aceratagallia.* At the time those studies were made, relatively little material belonging to this group was available. The accumulation of additional material, especially from California, has brought to light a number of new species, as well as specimens which alter somewhat the specific concepts established in the previous work. It seems desirable, therefore, to review the group again in order to incorporate the new species into the scheme

[1] Received June 15, 1939.
[2] Hawaiian Sugar Planters' Assoc. Expt. Sta., Div. Ent. Bull. 4: 61. May 1907.
[3] Hawaiian Sugar Planters' Assoc. Expt. Sta., Div. Ent. Bull. 3: 11, 30. Sept. 1907.
[4] U. S. Dept. Agr. Tech. Bull. 372: 46.

of classification, and to make such changes as are necessary in the interpretation of the previously described forms.

In order to avoid repetition in the specific descriptions that follow, a résumé of certain general characters is given at this point. The bases for the differentiation of *Ceratagallia* from other agallian leafhoppers have already been given. Thus defined, the genus constitutes a remarkably homogeneous group. The species are all rather robust, the slenderest being *lobata* (Oman), which resembles closely *Aceratagallia gillettei* (O. & B.) in general appearance. An accurate idea of the general habitus of the species may be gained by examination of Figures G, H, and I of Plate 2 of the writer's 1933 paper. Although color markings may be either present or absent, and vary from fuscous to brown within a species, when present they form a pattern that is very uniform throughout the genus. In the approximate order of their frequency of appearance in the adults, the color markings are as follows: A pair of round or ovate spots on the crown above the ocelli; a pair of triangular marks at the base of the scutellum; the veins of the corium, with the exception of the base of R+M, which is white, and the base of Cu_1, which is usually sordid yellowish white; a pair of slender stripes along the commissural line in the outer cells of the clavus, these usually fused with fainter markings which occur in the cells of the clavus and parallel the claval veins; irregular and frequently interrupted stripes along the claval suture, and indefinite elongate marks in the cells of the clavus and corium adjacent to the claval suture basally; a pair of narrow stripes along the median line, extending across the pronotum and crown, and fusing, on the face, with the stripes along the base of the clypeus; an interrupted arc on each side of the pronotum basally, this frequently connected with the median stripes, and usually connected with a broad inner vitta and a narrow outer vitta extending from the arc to the posterior margin of the pronotum; an irregular mark in each ocellocular area, with an extension toward the adjacent ocellus and one along the antennal pit; the facial sutures, antennal pits, and transverse bars on the clypeus laterally; the transverse suture of the scutellum, and a pair of small spots just anterior to it; various indefinite areas, which tend to be darker on the dorsum of the abdomen, the distal portions of the female pygofer and ovipositor sheath, the median line of the male plates, and the lateral portions of the sternites.

The nymphs normally have the spots on the crown reduced to oblique dashes. The paired median dorsal stripes are broader than in the

adult and continue to the apex of the abdomen, while the lateral portions of the dorsum are occupied with more or less continuous longitudinal marks which serve to accentuate the unmarked yellowish portion of the dorsum laterad of the median stripes. Other markings on the nymphs are somewhat similar to those of the adults, although the nymphs are more frequently entirely without markings.

Of the various structures of the internal male genitalia, that portion of the style caudad of its point of attachment to the genital capsule seems to be the only part furnishing characters reliable for specific differentiation. This part of the style is frequently boot-shaped in outline, and consists of a relatively slender basal portion, the shank, an expanded distal portion which is usually foot-shaped and hence conveniently termed the "foot" of the style, and usually a ventral projection called the ventral tooth. Of the parts of the foot of the style, the "heel" is formed by the angle adjacent to the serrated margin of the shank, and is usually distinctly less produced than the "toe." Although subject to some variation, the gross outline of the style is usually sufficiently characteristic to permit specific identification from this structure alone. The number and arrangement of the setae on the style and the minute details of the serrations on the inner margin are only helpful in a general way, but in the accompanying drawings they have been portrayed as accurately as possible for the sake of completeness.

The diagnostic characters of the styles of the males are most conveniently studied and illustrated if removed from the genital capsule. Consequently, in this study, following the customary treatment with caustic potash, the styles, connective, and aedeagus have been carefully dissected out and mounted in balsam on microscope slides. The cover glass should be pressed down sufficiently to orient the broadened distal portion of the style in a horizontal plane. These structures are best studied with a compound microscope at magnifications of from 60 to 120 diameters, although less magnification is satisfactory for most purposes.

The illustrations accompanying this paper were made on coordinate paper with the aid of a micrometer scale placed in the ocular of a compound microscope. All drawings show the outline of the distal portion of the right style in dorsal view, and since they are drawn to the same scale they give an accurate idea of the relative size of these structures in the various species.

CONCERNING A KEY

With the exception of the characters presented by the styles of the internal male genitalia, the differences between the various species of this group are usually such that they do not lend themselves well to use in a key. It seems impossible to indicate reasonably positive characters for the separation of the species without relying almost entirely upon the characters of the styles, and there seems no point in presenting a key when equally satisfactory results may be obtained, probably more efficiently, by comparing these structures with the accompanying illustrations. In the absence of a key it is perhaps well to indicate that the most reliable external characters are the size, relative robustness, and presence or absence of markings. Of the internal characters, the general outline of the foot of the style, the size and position of the ventral tooth, and the width and curvature of the shank have proven most useful in differentiating closely related species.

Ceratagallia lobata (Oman), n. comb. Fig. 1

Aceratagallia lobata Oman, U. S. Dept. Agr. Tech. Bull. **372**: 67. 1933.

A relatively slender, dark-colored species. Heel and toe of style of approximately equal size; style obliquely subtruncate distally. Length 2.8–3 mm.

External characters.—General ground color sordid cinereous; markings of brown and fuscous sufficiently extensive to give the entire insect a fuscous appearance. Male plates rather short, tapering slightly from base to apex.

Internal male genitalia.—Shank of style short and comparatively broad. Ventral tooth small and situated at about narrowest part of shank. Posterior margin of style slightly sinuate; inner margin distally finely serrate. Distal part of aedeagus flattened dorsoventrally, apex sagittate in outline.

Localities.—Type locality, Glendale, Nev. Type, U.S.N.M. no. 44650. Other material from the following localities examined. ARIZONA: Ashfork, Oak Creek Canyon, Prescott, Sacaton, Santa Rita Mountains, Yarnell Heights, and Yavapai County. CALIFORNIA: Alpine, Big Bear Lake, Mint Canyon, and San Jacinto Mountains. NEVADA: Glendale, Las Vegas, and Mesquite. UTAH: St. George.

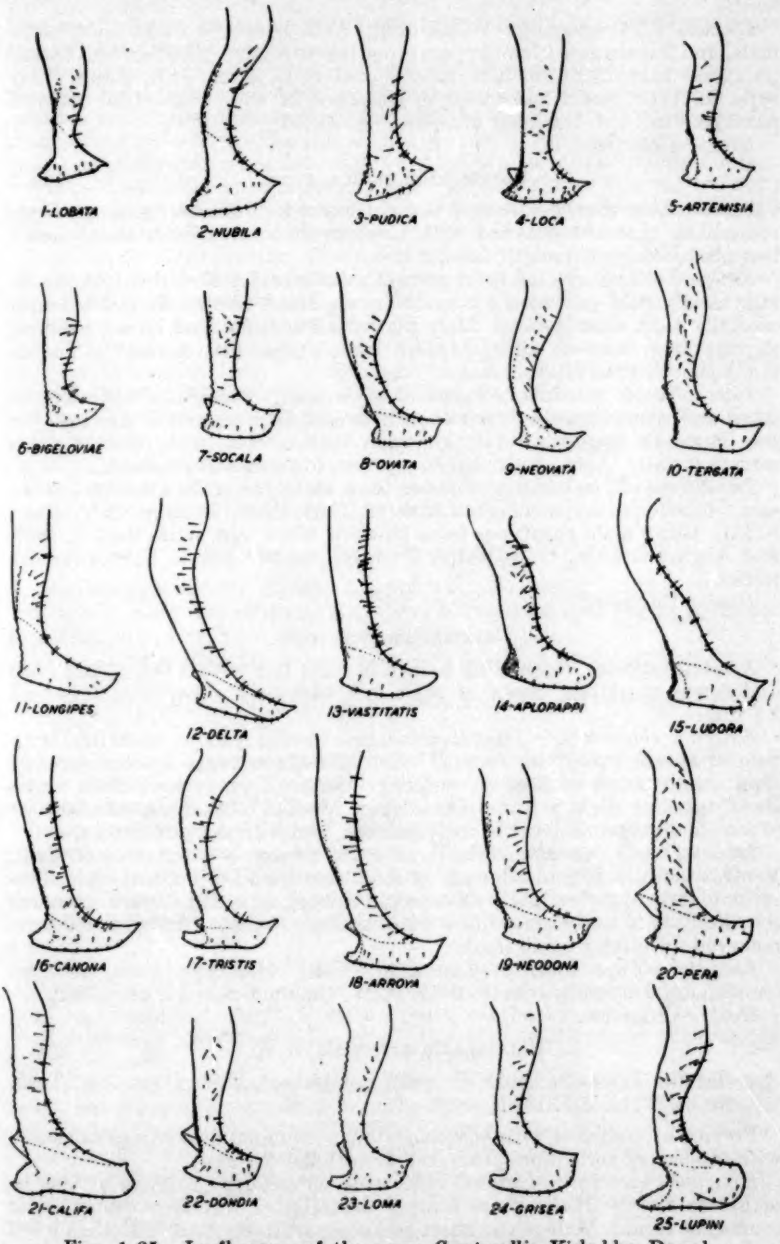
Host.—Unknown.

Ceratagallia nubila, n. sp. Fig. 2

Resembling dark specimens of *dondia* in general appearance, but with the male plates broader distally and the styles more like those of *lobata*, with the heel and toe of nearly equal size. Length 3.25–3.5 mm.

External characters.—General ground color sordid yellowish white; brown and fuscous markings much more clearly delimited than in *lobata*. Male plates long and nearly parallel margined, proportionally wider than those of *lobata*.

Internal male genitalia.—Shank of style slender, rather long, and distinctly sinuate. Ventral tooth very small, and located as in *lobata*. Posterior margin of style obliquely subtruncate, inner margin distally finely serrate. Aedeagus with a blunt tooth on dorsal margin just before apex.



Figs. 1–25.—Leafhoppers of the genus *Ceratagallia* Kirkaldy: Dorsal views of distal portion of right style.

Locality.—Type locality, Wickenburg, Ariz. Holotype male, allotype female, and 2 male and 1 female paratypes taken August 20, 1938, and 2 male paratypes taken June 16, 1937, all collected by D. J. and J. N. Knull. Holotype, allotype, and 2 paratypes in collection of Ohio State University; 3 paratypes in U. S. National Museum, no. 53350.

Host.—Unknown.

Ceratagallia pudica, n. sp. Fig. 3

More robust than *nubila* and without extensive fuscous markings. Style resembling that of *lobata* but with a relatively more slender shank and a less produced heel. Length 2.8–3.2 mm.

External characters.—General ground color sordid yellowish white; markings mostly pale yellowish brown or brown. Head tumid, distinctly longer medially than next the eye. Male plates rather short and broad, tapering slightly from base to apex. Median lobes of seventh sternite of female much shorter than lateral lobes.

Internal male genitalia.—Shank of style nearly straight. Ventral tooth small and situated nearer apex than in *lobata*. Heel distinctly shorter than toe. Posterior margin of style obliquely subtruncate; inner margin finely serrate distally. Apex of aedeagus recurved, forming a slight hook.

Localities.—Type locality, Tucson, Ariz. Holotype male, allotype female, and 1 female paratype collected June 18, 1933, P. W. Oman, U.S.N.M. no. 53351. Also 2 male paratypes from Hualpai Mountain, Ariz., July 4, 1937, and August 6, 1938, D. J. and J. N. Knull, in Ohio State University collection.

Host.—Unknown.

Ceratagallia loca, n. sp. Fig. 4

A robust species, resembling *pudica* in form but with a less tumid head and fewer markings. Apex of style not obliquely subtruncate. Length 2.8 mm.

External characters.—General color pale sordid yellow; markings very pale or absent except for fuscous veins of corium, ovate fuscous spots on crown, and traces of arcs on anterior margin of pronotum. Male plates short, tapering slightly from base to apex. Median lobes of seventh sternite of female divergent, rather sharply pointed, and with margins brown.

Internal male genitalia.—Shank of style relatively stout and straight. Ventral tooth large and pointed, situated just basad of apex of style. Posterior margin of style slightly sinuate and curving cephalad toward attenuate toe; heel short and stout; inner margin finely serrate. Apex of aedeagus recurved, forming a small hook.

Locality.—Type locality, Lancaster, Calif. Holotype male, allotype female, and 1 nymph, June 8, 1935, P. W. Oman, U.S.N.M. no. 53352.

Host.—Unknown.

Ceratagallia artemisia, n. sp. Fig. 5

Aceratagallia bigeloviae Oman (in part, not Baker), U. S. Dept. Agr. Tech. Bull. 372, pl. 2, I. 1933.

Previously confused with *bigeloviae*, but with much darker markings and with the heel of style more produced. Length 2.5–2.7 mm.

External characters.—General color pale cinereous; markings of fuscous or brown mostly distinct and sharply delimited. Form very robust, head somewhat tumid. Male plates short and comparatively broad. Median lobes

of seventh sternite of female nearly as long as lateral lobes, longer and more slender than those of *bigeloviae*.

Internal male genitalia.—Shank of style slightly sinuated and more slender than that of *bigeloviae*. Ventral tooth small and situated more basad than in *bigeloviae*. Posterior margin of style curving less gradually to apex of toe than in *bigeloviae;* heel, although variable in size, usually strongly produced; inner margin irregularly serrate distally. Apex of aedeagus distinctly hooked.

Note.—This is the species represented by Plate 2, I, of the writer's 1933 paper on the group. At that time only a few specimens were available, and they were believed to be dark-colored examples of *bigeloviae*.

Localities.—Type locality, Twin Falls, Idaho. Holotype male, allotype female, and 2 male and 8 female paratypes, May 6, 1937, J. A. Gillett. Also the following paratypes from Idaho. Hollister: 1 male and 1 female, August 27, 1928, D. E. Fox; 2 females, May 19, 1931, D. E. Fox; 1 male, July 24, 1931, D. E. Fox; 1 male, August 23, 1933, D. E. Fox. Wendell: 1 male, May 19, 1933; 2 females, June 9, 1933. Hagerman: 1 male, September 13, 1932. Berger: 1 female, May 20, 1937, J. A. Gillett. Castleford: 1 female, November 14, 1936. There are also at hand 2 males and 1 female from Salt Lake City, April 25, 1936, C. F. Smith. Types in U. S. National Museum, no. 53353, paratypes in collection of Joseph A. Gillett.

Host.—Presumably *Artemisia tridentata*, since most of the above specimens are recorded as being from that plant.

Ceratagallia bigeloviae (Baker) Fig. 6

Agallia bigeloviae Baker, Psyche **7**(suppl. 12): 26. 1896.
Ceratagallia bigeloviae (Baker), Kirkaldy, Hawaiian Sugar Planters' Assoc. Expt. Sta., Div. Ent. Bull. **4**: 61. 1907.
Agallia (*Aceratagallia*) *bigeloviae* Baker, Van Duzee, Check List Hemiptera, p. 64. 1916.
Aceratagallia bigeloviae (Baker), Oman, U. S. Dept. Agr. Tech. Bull. **372**: 66. 1933.

A small, robust species marked with brown or fuscous. Style without a prominent heel and with the ventral tooth located distad of narrowest part of shank. Length 2.5–2.75 mm.

External characters.—General color sordid yellowish white; markings, except the pair of fuscous spots on crown, usually pale brown and indefinite but sometimes fuscous. Median portion of face often tinged with pink. Male plates comparatively large, tapering gradually from base to apex. Median lobes of seventh sternite of female shorter than lateral lobes and bluntly pointed.

Internal male genitalia.—Shank of style rather stout, inner margin nearly straight. Ventral tooth small and located distad of the constricted portion of shank. Posterior margin of style evenly curved from heel to toe; heel usually forming a right angle; toe slightly attenuated. Apex of aedeagus slightly hooked.

Localities.—Type locality, Albuquerque, N. Mex. Type, U.S.N.M. no. 44014. Other material examined from the following localities. TEXAS: Marfa and Taylor County. KANSAS: Phillips County. COLORADO: Fort Collins. UTAH: Leeds, Provo, Salt Lake City, Santa Clara, and St. George. ARIZONA: Congress Junction, Grand Canyon, Prescott, and Yavapai County. NEW MEXICO: Carlsbad, Colfax County, Las Cruces, Organ Mountains, Roswell, and White Sands.

Host.—Probably *Chrysothamnus.*

Notes.—There still remains some doubt as to the exact identity of *bigeloviae.* The type is a female and consequently difficult to identify with certainty; other specimens from the type locality are needed. Furthermore, the material studied and here treated as *bigeloviae* shows some variation around a mean which seems best exemplified by specimens from southern New Mexico. Specimens at hand from California are uniformly darker colored than material from other localities and may constitute a distinct form, but at present seem inseparable on the basis of structural characters.

Ceratagallia socala, n. sp. Fig. 7

Related to *artemisia* but less robust and with a more tumid head. Ventral tooth of style larger than that of *artemisia* and located on foot. Length 2.6–2.9 mm.

External characters.—General color pale cinereous; markings mostly very variable, the most constant being those on the pronotum and forewings. Spots on crown above ocelli usually distinctly ovate, occasionally absent. Head tumid, distinctly longer medially than next eye. Male plates proportionally smaller than those of *artemisia.* Median lobes of seventh sternite of female short and blunt.

Internal male genitalia.—Shank of style rather short and straight, tapering gradually from base to narrowest part, then abruptly expanded into the footlike distal part. Ventral tooth rather large and pointed, located on the foot of the style. Inner margin of shank rather coarsely serrate distally; heel scarcely produced; toe broad basally, apex slightly attenuate. Apex of aedeagus pointed.

Localities.—Type locality, Santa Maria, Calif. Holotype male, allotype female, and 16 male and 17 female paratypes collected July 19, 1933, R. H. Beamer. Also 13 male and 8 female paratypes from San Jacinto Mountains, Calif., June 30, 1933, R. H. Beamer. Types in collection of University of Kansas, paratypes in U. S. National Museum, no. 53354.

Host.—Unknown.

Ceratagallia ovata (Oman), n. comb. Fig. 8

Aceratagallia ovata Oman, Journ. Kansas Ent. Soc. **8**: 14. 1935.

A robust species, larger than *bigeloviae.* Shank of style much broader basally than distally; ventral tooth broad. Length 2.75–3 mm.

External characters.—General ground color pale yellow; markings mostly faint or absent except for oval spots on crown, basal triangles on scutellum, and markings on forewings. Clypeus usually tinged with pink. Male plates about twice as long as their combined basal width, tapering rather abruptly. Median lobes of seventh sternite of female shorter than lateral lobes, but well produced and bluntly pointed.

Internal male genitalia.—Shank of style broad basally, but tapering sharply to a rather slender median portion. Ventral tooth broad basally, located just basad of foot of style. Inner margin of shank finely serrate distally; heel scarcely produced; toe large, broader than narrowest part of shank and with tip slightly attenuate. Aedeagus with a blunt tooth near apex.

Locality.—Type locality, Yarnell Heights, Ariz. Type, U.S.N.M. no. 50368. There are also specimens at hand from Mojave, Calif.

Host.—Unknown.

Ceratagallia neovata, n. sp. Fig. 9

Resembling *socala* in general appearance, but with a less tumid head. Style similar to that of *ovata*, but more slender basally. Length 2.7–2.9 mm.

External characters.—General ground color pale cinereous; markings on pronotum faint, others usually distinct but not sharply delimited. Male plates as in *lobata*. Median lobes of seventh sternite of female bluntly pointed and nearly as long as lateral lobes.

Internal male genitalia.—Shank of style much more slender basally than in *ovata*, slightly sinuate and tapering gradually to footlike extremity. Ventral tooth small and bluntly pointed. Inner margin of shank finely serrate distally; heel small; toe slenderer and tip more attenuate than in *ovata*. Aedeagus with blunt tooth near apex.

Localities.—Type locality, Warner Springs, Calif. Holotype male, allotype female, and 1 male paratype, June 3, 1935, P. W. Oman, U.S.N.M. no. 53355. Also 1 male paratype from Beaumont, Calif., July 26, 1933, R. H. Beamer, in collection of the University of Kansas.

Host.—Unknown.

Ceratagallia tergata (Van Duzee), n. comb. Fig. 10

Agallia tergata Van Duzee, Proc. California Acad. Sci. (4) **12**: 172. 1923.
Aceratagallia tergata (Van Duzee), Oman, U. S. Dept. Agr. Tech. Bull. **372**: 69. 1933.

A comparatively large, robust species, usually without markings. Male plates short and broad. Length 3–3.25 mm.

External characters.—General ground color pale, sordid cinereous; markings usually entirely absent but sometimes present, particularly those along median line of head and pronotum and veins of corium. Clypeus sometimes suffused with pale orange. Entire body sometimes with a whitish bloom. Male plates broad, scarcely tapering from base to blunt apex. Median lobes of seventh sternite of female rather short and bluntly pointed, median emargination between these lobes unusually wide and deep.

Internal male genitalia.—Shank of style distinctly sinuate. Ventral tooth rather small, situated well basad of apex of style. Inner margin of shank finely serrate distally; heel small; toe rather long, with apex curved slightly cephalad. Apex of aedeagus hooked.

Localities.—Type locality, Tortuga Island, Gulf of California. Type in collection of the California Academy of Sciences. Other material from the following localities examined: CALIFORNIA: Beaumont, Coachella, Riverside, and Soboba Springs. ARIZONA: Sabino Canyon, Santa Rita Mountains, and Tucson.

Host.—*Encelia.*

Ceratagallia longipes, n. sp. Fig. 11

Closely related to *tergata*, but with ovate spots on crown always present, and shank of style not sinuate. Length 3–3.25 mm.

External characters.—General ground color pale cinereous. Spots on crown small, other markings usually absent, although the basal triangles on scutellum and faint marks on distal portions of forewings are occasionally present. Clypeus usually very faintly tinged with pink. Male plates more slender than those of *tergata*, and tapering slightly from base to apex. Median lobes of seventh sternite of female as in *tergata*.

Internal male genitalia.—Shank of style relatively straight. Ventral tooth small, located basad of narrowest part of shank. Inner margin of shank serrate distally; heel but little produced; toe greatly produced and slender, thus making the foot of the style very long. Apex of aedeagus hooked.

Localities.—Type locality, Mojave, Calif. Holotype male, allotype female, and 11 male and 5 female paratypes collected July 7, 1933, R. H. Beamer. Other paratypes: 2 males and 5 females from Kelso, Calif., June 9, 1908, E. D. Ball; 1 male from Big Bear Lake, Calif., July 26, 1932, R. H. Beamer; 1 male from Palm Springs, Calif., May 23, 1917, E. P. Van Duzee; and 2 females from Palm Springs, Calif., May 21, 1917, E. P. Van Duzee. Holotype, allotype, and paratypes in collection of the University of Kansas, paratypes in collections of the U. S. National Museum, no. 53356, the California Academy of Sciences, and E. D. Ball.

Host.—Unknown.

Ceratagallia delta, n. sp. Fig. 12

A rather robust, well-marked species with very broad male plates and long median lobes of the seventh sternite of the female. Length 3.1–3.25 mm.

External characters.—General ground color sordid yellowish white; markings mostly of brown or fuscous and distinct, the oval spots on crown comparatively large. Head distinctly produced and tumid medially. Male plates very broad and scarcely tapering from base to apex, caudal opening of pygofer unusually large. Median lobes of seventh sternite of female nearly as long as lateral lobes, rather slender and slightly divergent distally, the median emargination between them narrow.

Internal male genitalia.—Shank of style long and rather slender, with a distinct bend near base. Ventral tooth blunt, located on base of foot of style. Inner margin of shank minutely serrate distally; heel small; toe slender and pointed. Apex of aedeagus blunt.

Locality.—Type locality, Delta, Calif. Holotype male, allotype female, and 41 male and 23 female paratypes collected June 28, 1935, P. W. Oman, U.S.N.M. no. 53357.

Host.—Unknown.

Ceratagallia vastitatis (Oman), n. comb. Fig. 13

Aceratagallia vastitatis Oman, U. S. Dept. Agr. Tech. Bull. **372**: 69. 1933.

Less robust than *delta*, with male plates smaller and the shank of the style nearly straight. One of the largest species in the genus. Length 3.5–3.75 mm.

External characters.—General ground color pale sordid yellow; markings mostly brown and rather indefinite except for the pair of fuscous spots on crown. Head scarcely produced medially. Male plates broad, but not so broad as those of *delta*, tapering slightly from base to apex. Median lobes of seventh sternite of female bluntly pointed, nearly equal to lateral lobes in length.

Internal male genitalia.—Shank of style nearly straight, not tapering distally. Ventral tooth small, located on base of foot. Posterior margin evenly rounded; inner margin of shank very finely serrate distally; heel scarcely produced; toe well produced and bluntly pointed. Apex of aedeagus slightly hooked.

Localities.—Type locality, Lund, Utah. Type, U.S.N.M. no. 44017. Material from the following localities examined: UTAH: Dixie, Leeds, and

Lund. NEVADA: Glendale, Las Vegas, and Overton. CALIFORNIA: Indio, Fort Yuma, and Potholes. ARIZONA: Littlefield and Yuma.

Host.—Pluchea sericea.

Ceratagallia aplopappi (Oman), n. comb. Fig. 14

Aceratagallia aplopappi Oman, U. S. Dept. Agr. Tech. Bull. 372: 67. 1933.

A robust species, easily separated from other species of the genus by the strongly arched male plates. Length 2.75–3 mm.

External characters.—General ground color pale yellow; markings, except the pair of fuscous spots on crown, varying from pale yellowish brown to fuscous. Male plates strongly arched downward, broad basally, tapering gradually to the rounded and slightly divergent apices. Male pygofer with numerous fine, white hairs laterally. Median lobes of seventh sternite of female as long as lateral lobes, pointed and closely appressed to the pygofer, which is usually shallowly grooved for their reception.

Internal male genitalia.—Shank of style slightly sinuate, not tapered distally. Ventral tooth absent. Inner margin of shank finely serrate distally; heel rounded and serrate, with the adjacent surface of the foot finely dentate; apex of toe bluntly rounded. Apex of aedeagus slightly hooked.

Localities.—Type locality, Pima County, Ariz. Type in collection of the University of Kansas. Material from the following localities examined: ARIZONA: Baboquivari Mountains, Benson, Coconino County, Maricopa County, Mescal, Phoenix, Pima County, Red Rock, Sabino Canyon, Santa Rita Mountains, Sasabe, Tempe, Tucson, and Yarnell Heights. NEW MEXICO: Belen.

Host.—Aplopappus.

Ceratagallia ludora, n. sp. Fig. 15

A robust species with a short, broad head. Shank of style more slender basally than distally. Length 3–3.2 mm.

External characters.—General ground color pale cinereous, head tinged with pale yellow; markings, except the pair of fuscous spots on crown, mostly indefinite. Male plates rather large, about as in *vastitatis*. Median lobes of seventh sternite of female as long as lateral lobes, tips rounded.

Internal male genitalia.—Shank of style with base rather strongly curved and more slender than distal portion. Ventral tooth located on foot of style. Inner margin of shank finely, irregularly serrate distally; heel scarcely produced; toe broad, apex attenuate. Aedeagus with a small tooth near apex.

Localities.—Type locality, Perris, Calif. Holotype male, allotype female, and 3 male and 2 female paratypes collected June 5, 1935, P. W. Oman, U.S.N.M. no. 53358. Also the following paratypes from San Diego County, Calif., collected by E. P. Van Duzee: 1 male, April 22, 1913; 1 male and 1 female, October 3, 1913(?); and 1 male March 11, 1914. In collection of California Academy of Sciences.

Host.—Unknown.

Ceratagallia canona, n. sp. Fig. 16

A rather slender species with head slightly produced. Shank of style nearly straight, foot of style slender. Length 3–3.5 mm.

External characters.—General ground color pale cinereous, head often tinged with pale yellow; markings frequently indistinct, the pair of fuscous spots on crown usually ovate and oblique. Male plates comparatively large

tapering gradually from base to apex. Median lobes of seventh sternite of female slightly shorter than lateral lobes, diverging slightly, tips bluntly pointed.

Internal male genitalia.—Shank of style rather slender. Ventral tooth slender and sharply pointed, located on foot of style. Inner margin of shank finely serrate on distal half; heel well produced and ending in a sharp point; toe rather slender and sharply pointed. Apex of aedeagus blunt.

Localities.—Type locality, Mint Canyon, Calif. Holotype male, allotype female, and 6 male and 5 female paratypes collected June 7, 1935, P. W. Oman, U.S.N.M. no. 53359. Also 4 male and 10 female paratypes from Beaumont, Calif., July 26, 1933, R. H. Beamer, in collection of University of Kansas, and the following paratypes from California, collected by E. P. Van Duzee, and deposited in the California Academy of Sciences: 2 males, San Diego County, June 18, 1913; 1 male, Alpine, September 13, 1923; and 1 male and 1 female, Mint Canyon, April 20, 1932.

Host.—Unknown.

Ceratagallia tristis, n. sp. Fig. 17

A rather slender species, related to *canona*, but darker colored and with the shank of the style more slender and curved. Length 3.2–3.4 mm.

External characters.—General ground color sordid yellowish white, head and anterior portion of pronotum tinged with pink; markings mostly fuscous usually not sharply delimited on fore wings, and sufficiently extensive to give the entire insect a fuscous appearance. White mark on base of R+M conspicuous. Male plates rather slender, tapering gradually from base to apex. Median lobes of seventh sternite of female short and blunt, the median emargination separating them broadly V-shaped, the lateral emarginations narrow.

Internal male genitalia.—Shank of style broadly curved, tapering slightly from base. Ventral tooth prominent, located just basad of outer point. Inner margin of shank irregularly serrate on distal two-thirds; heel well produced and usually bifid; apex of toe slightly attenuate. Apex of aedeagus hooked.

Localities.—Type locality, Perris, Calif. Holotype male, allotype female, and 2 male and 6 female paratypes collected June 5, 1935, P. W. Oman, U.S.N.M. no. 53360. Other paratypes from California as follows: 1 male, San Francisco, April 27, 1908, E. D. Ball, in collection of E. D. Ball; 1 male, San Francisco, April 18, 1917, W. M. Giffard, in collection of California Academy of Sciences; 3 males, Beaumont, July 26, 1933, R. H. Beamer; 1 male, Winters, August 5, 1929, R. H. Beamer; 1 female, Alpine, July 9, 1929, R. H. Beamer, in collection of the University of Kansas.

Host.—Unknown.

Ceratagallia arroya, n. sp. Fig. 18

A robust species, usually heavily marked with fuscous. Style similar to that of *tristis* but stouter and with shank less strongly curved. Length 3.1–3.4 mm.

External characters.—General ground color pale cinereous; markings unusually dark, especially those on the crown and pronotum, the white areas on fore wings thus conspicuous in contrast. Head slightly produced medially. Male plates much wider basally than distally. Median lobes of seventh sternite of female rather short, diverging and bluntly pointed.

Internal male genitalia.—Shank of style slightly curved. Ventral tooth prominent and pointed, located a little more basad than that of *tristis*. Inner

margin of shank finely and irregularly serrate on distal half; heel bifid but proportionally smaller than that of *tristis;* toe slightly attenuate. Apex of aedeagus slightly hooked.

Localities.—Type locality, Saugus, Calif. Holotype male, allotype female, and 17 male and 17 female paratypes collected June 7, 1935, P. W. Oman, U.S.N.M. no. 53361. Also 17 male and 12 female paratypes from Mill Creek Canyon, San Bernardino Mountains, Calif., collected September 23–25, 1923, by E. P. Van Duzee, in collection of California Academy of Sciences. There are also specimens at hand from the following California localities: Lompoc, Ontario, Pasadena, and San Diego County.

Host.—Eriodictyon.

Ceratagallia neodona, n. sp. Fig. 19

Closely related to *dondia,* but style with a longer toe and a much smaller ventral tooth. Length 3.6–3.9 mm.

External characters.—General ground color pale yellowish cinereous; markings, except the pair of small fuscous spots on crown, usually faint or absent, when present brown veins of the forewings and the traces of the lateral arcs on pronotum are most prominent. Male plates rather slender, tapering distally. Median lobes of seventh sternite of female rather small, bluntly pointed and diverging, the lateral emarginations separating them from the lateral lobes very narrow.

Internal male genitalia.—Shank of style stout. Ventral tooth pointed, located just basad of foot of style. Inner margin of shank serrate on distal half; heel small; toe comparatively large and considerably longer than that of *dondia,* apex slightly attenuate. Apex of aedeagus slightly hooked.

Locality.—Type locality, Nixon, Nev. Holotype male, allotype female, and 5 female paratypes collected June 20, 1927, 7 female paratypes collected June 30, 1927, by E. P. Van Duzee. Types in collection of California Academy of Sciences, 4 paratypes in collection of U. S. National Museum, no. 53362.

Host.—Unknown.

Ceratagallia pera, n. sp. Fig. 20

Closely related to *arroya* and *dondia,* but with toe of style very large and ventral tooth of style larger than in either of those species. Length 3.6–3.9 mm.

External characters.—General ground color pale yellow or yellowish cinereous; markings very faint or absent, except the pair of small fuscous spots on crown and sometimes the brown veins of forewings. Male plates comparatively small, tapering sharply from base to apex. Lobes of seventh sternite of female short, median lobes blunt.

Internal male genitalia.—Shank of style stout and of nearly uniform width. Ventral tooth very large and angular, located just basad of foot of style. Inner margin of shank coarsely and irregularly serrate on distal two-thirds; heel rather small; toe very large, apex pointed but not attenuate. Apex of aedeagus blunt.

Locality.—Type locality, Perris, Calif. Holotype male, allotype female, and 14 male and 20 female paratypes collected June 5, 1935, P. W. Oman, U.S.N.M. no. 53363.

Host.—Unknown.

Ceratagallia califa, n. sp. Fig. 21

Related to *pera,* which it resembles in general appearance, but style with a smaller ventral tooth and a larger heel. Length 3.2–3.75 mm.

External characters.—General ground color yellowish white; markings usually either very faint or entirely absent, the pair of spots on crown, when present, small and elongate-ovate in shape. Male plates similar to those of *pera*, but slightly longer. Lobes of seventh sternite of female short and blunt.

Internal male genitalia.—Shank of style more slender and more curved than that of *pera*. Ventral tooth prominent and angular, located just basad of inner point. Posterior margin of style very shallowly emarginate; inner margin of shank irregularly serrate on posterior two-thirds; heel well produced and pointed; toe large and blunt, with a nipplelike projection at laterocephalic angle. Apex of aedeagus slightly hooked.

Localities.—Type locality, Califa, Calif. Holotype male, allotype female, and 22 male and 36 female paratypes collected June 12, 1935, P. W. Oman, U.S.N.M. no. 53364. Also 4 male and 5 female paratypes from Selma, Calif., June 4, 1929, E. P. Van Duzee, in collection of California Academy of Sciences. Other specimens from Los Banos and Bakersfield, Calif., examined.

Host.—Probably *Dondia*.

Ceratagallia dondia (Oman), n. comb. Fig. 22

Aceratagallia dondia Oman, U. S. Dept. Agr. Tech. Bull. **372**: 68. 1933.

A large, rather robust species. Style with a relatively short toe and a large, angular, ventral tooth, Length 3.4–3.75 mm.

External characters.—General ground color pale yellow; markings, with the exception of the pair of fuscous spots on crown, frequently faint or absent, when present usually brown but occasionally fuscous. Male plates comparatively slender, width basally about twice the apical width. Median lobes of seventh sternite of female shorter than lateral lobes and bluntly rounded.

Internal male genitalia.—Shank of style nearly straight and rather broad basally. Ventral tooth large and angular, located just basad of foot of style at narrowest part of shank. Posterior margin of style broadly and rather uniformly rounded; inner margin of shank finely and irregularly serrate; heel well produced and angular; toe rather short, about as long as greatest width of shank, apex angled but not attenuate.

Localities.—Type locality, Thermal, Calif. Type, U. S. N. M. no. 44016. Other material from the following localities examined. CALIFORNIA: Catalina Island, Coachella, Fort Yuma, and Panamint Mountains. NEVADA: Bunkerville, Las Vegas, and Overton. UTAH: Delta, Grantsville, and Leeds. ARIZONA: Sacaton, Tucson, and Yuma. COLORADO: Grand Junction and Rocky Ford. TEXAS: El Paso.

Host.—Dondia.

Ceratagallia loma, n. sp. Fig. 23

Resembling *artemisia* and *bigeloviae* in size and general form, but more closely related to *grisea* on the basis of the shape of the style. Smaller than grisea and with the shank of the style more coarsely serrate. Length 2.6–2.7 mm.

External characters.—General ground color sordid cinereous, head tinged with yellow; markings mostly fuscous and sharply delimited, the median stripes on crown diverging posteriorly. A robust species with head slightly tumid. Male plates comparatively large, very little narrowed distally. Median emargination in posterior margin of seventh sternite of female broad but not angular; median lobes short and blunt.

Internal male genitalia.—Shank of style slightly sinuately curved, broader basally than near foot. Ventral tooth rather large and angular, located just distad of narrowest part of shank. Inner margin of shank coarsely and irregularly serrate except basally; heel well produced and slightly bifid; toe rather broad, with anterolateral angle attenuated. Apex of aedeagus slightly hooked.

Locality.—Type locality, Warner Springs, Calif. Holotype male, allotype female, and 1 male paratype collected June 3, 1935, P. W. Oman, U.S.N.M. no. 53365.

Host.—Unknown.

Ceratagallia grisea (Oman), n. comb. Fig. 24

Aceratagallia grisea Oman, Journ. Kansas Ent. Soc. **8**: 13. 1935.

A robust gray species marked with fuscous. Style with shank rather slender and toe broad and short. Length 3 mm.

External characters.—General ground color pale gray, clypeus tinged with pink; markings usually sharply delimited. Pronotal markings variable, those most often present being the two median stripes and a spot near each lateral margin which represents a trace of the lateral stripe. Male plates rather long and slender, tapering gradually from base to apex. Median emargination in posterior margin of seventh sternite of female broadly V-shaped, median lobes bluntly pointed and nearly as long as lateral lobes.

Internal male genitalia.—Shank of style slightly sinuate, becoming narrower distally. Ventral tooth blunt, located at base of foot of style. Inner margin of shank irregularly serrate; heel well produced and usually bifid; toe broad and relatively short, the anterolateral angle less attenuated than in *loma*. Apex of aedeagus slightly hooked.

Locality.—Type locality, Ramsey Canyon, Huachuca Mountains, Ariz. Type, U.S.N.M. no. 50367.

Host.—Unknown.

Ceratagallia lupini, n. sp. Fig. 25

A robust species, related to *grisea* but larger and paler, the style with shank more strongly curved and toe broader. Length 3.4–3.9 mm.

External characters.—General ground color sordid white to pale gray, head sometimes tinged with pale yellow. Markings frequently entirely absent, always considerably reduced and usually faint. Head slightly tumid. Male plates as in *grisea*. Male pygofer with numerous fine white hairs laterally. Median lobes of seventh sternite of female bluntly pointed and slightly shorter than lateral lobes, the median emargination separating them not angular.

Internal male genitalia.—Shank of style strongly, sinuately curved. Ventral tooth located on base of foot of style. Inner margin of shank irregularly serrate on distal two-thirds; heel well produced; toe very broad and blunt, the antero-lateral angle not attenuated.

Localities.—Type locality, Three Rivers, Calif. Holotype male, allotype female, and 19 male and 28 female paratypes, collected June 9, 1935, P. W. Oman, U.S.N.M. no. 53366. Other paratypes, 14 males and 14 females from San Francisco, Calif., June 20, 1935, P. W. Oman, and 5 males and 13 females from Santa Maria, Calif., July 19, 1933, R. H. Beamer.

Host.—*Lupinus.*

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

NEW MEMBERS ELECTED

The following have recently been elected to membership in the Academy:

Active resident members:

CHARLES ARMSTRONG, senior surgeon, U. S. Public Health Service, in recognition of his contributions in the fields of medical bacteriology and immunology and particularly for his studies on poliomyelitis and lymphocytic chorio-meningitis.

RAYMOND MCGEARY HANN, chemist, National Institute of Health, in recognition of his contributions to the chemistry of sugars and related compounds.

WILLIAM VINCENT LAMBERT, senior animal husbandman, in charge, Genetics Division, U. S. Bureau of Animal Industry, in recognition of his contributions to avian and mammalian genetics, especially in the field of inheritance of disease resistance and of inbreeding.

HARALD ALFRED REHDER, assistant curator, Division of Mollusks, U. S. National Museum, in recognition of his scientific attainments in the field of malacology.

FRANCIS OWEN RICE, head of the Department of Chemistry, Catholic University of America, in recognition of his contributions to the study of the kinetics of organic reactions, in particular his researches on free radicals.

IRL CORLEY SCHOONOVER, associate chemist, National Bureau of Standards, in recognition of his contributions to potentiometric methods of chemical analysis and the properties of silver and dental materials.

J. LEON SHERESHEFSKY, chairman of the Department of Chemistry, Howard University, in recognition of his work on capillarity, adsorption, and surface tension.

WILLIAM R. VAN DERSAL, biologist, U. S. Soil Conservation Service, in recognition of his work on food plants of native game.

MILTON VICTOR VELDEE, surgeon, U. S. Public Health Service, in recognition of his contributions to medical bacteriology, immunology, and epidemology, in particular his studies on scarlet fever.

ERNEST PILLSBURY WALKER, assistant director, National Zoological Park, Smithsonian Institution, in recognition of his attainments in biology, with special reference to mammals.

Active nonresident members:

CARL JOHN DRAKE, head of the Department of Zoology and Entomology, Iowa State College, and State Entomologist, Ames, Iowa, in recognition of his contributions to the taxonomy of the Hemiptera, especially the families Tingitidae and Gerridae.

WILLIAM ALBERT HOFFMAN, assistant professor of parasitology, School of Tropical Medicine, San Juan, P. R., in recognition of his contributions to medical entomology and parasitology.

ROBERT MATHESON, professor of entomology, Cornell University, Ithaca, N. Y., in recognition of his researches in medical entomology, particularly his work on the taxonomy of mosquitoes.

Honorary members:

CARLOS DE LA TORRE Y DE LA HUERTA, School of Sciences, University of Havana, Havana, Cuba, in recognition of his scientific attainments.

HENRI F. PITTIER, botanist and administrator of Agriculture, Caracas, Venezuela, in recognition of his contributions to the botany of South and Central America.

LEONHARD STEJNEGER, head curator of biology, U. S. National Museum, in recognition of his contributions to herpetology, ornithology, and mammalogy.

INCREASE IN RESIDENT MEMBERS VOTED

As a result of the balloting ending July 4, 1939, the membership of the Academy overwhelmingly voted to increase the number of resident active members from 400 to 450. There are, therefore, approximately 50 vacancies in the resident membership. This is brought to the attention of the members with the suggestion that they nominate those from among their associates who are eligible for membership. Nomination blanks may be obtained from the Corresponding Secretary and should be returned to the present Chairman of the Membership Committee, E. W. PRICE, U. S. Bureau of Animal Industry.

AWARDS FOR SCIENTIFIC ACHIEVEMENT

At its meeting on October 20, 1939, the Board of Managers of the Academy voted the establishment of awards for noteworthy discovery, accomplishment, or publication in the physical, biological, and engineering sciences, respectively. An award will be presented in each of these three fields not oftener than once in any calendar year. The awards, which will take the form of suitably inscribed certificates and be appropriately presented, will be limited to persons 40 or less years of age who are members of the Academy, resident or nonresident, or to members of societies affiliated with the Academy resident in the Washington area. The Committee on Awards, which has been appointed by the President of the Academy, will make recommendations each year to the Board of Managers not later than the annual meeting of the Academy, and the first awards may be made for the calendar year 1940. President CHAMBLISS has divided the Committee on Awards (JAMES F. COUCH, temporary chairman) into three subcommittees, one for each of the three fields of science concerned: *Biological Sciences*, AUSTIN H. CLARK, FREDERICK A. COE, JOHN M. COOPER, HOWARD A. EDSON, E. A. GOLDMAN (temporary chairman), H. W. SCHOENING, GOTTHOLD STEINER, ALEXANDER WETMORE; *Physical Sciences*, ARNOLD K. BALLS, OSCAR S. ADAMS, FERDINAND G. BRICKWEDDE, JAMES F. COUCH (temporary chairman), W. EDWARDS DEMING, OLIVER H. GISH, OSCAR E. MEINZER, FRED L. MOHLER, WALDEMAR T. SCHALLER, GEORGE TUNELL, ROGER C. WELLS, EDGAR W. WOOLARD, OLIVER R. WULF; *Engineering Sciences*, WILLIAM BOWIE, HARVEY L. CURTIS (temporary chairman), FRANCIS M. DEFANDORF, HERBERT G. DORSEY, JOHN W. MCBURNEY, H. L. WHITTEMORE, PAUL C. WHITNEY.

PUBLICATION OF MONOGRAPHS

It has been felt for some time that much valuable scientific material has been lost for want of publication and that the Academy should undertake the publication of scientific monographs to care for part of this problem

Accordingly, at its meeting on October 20, 1939, the Board of Managers of the Academy approved the establishment of a Committee on Monographs, whose functions will be to select appropriate manuscripts and arrange for their publication in the form of monographs. Preference will be given to manuscripts prepared by members of the Academy. The Committee on Monographs consists of six members, each appointed to serve a term of three years, except that of the first appointees, two are for one year, two are for two years, and two are for three years, and that the retiring Senior Editor of the JOURNAL is one of the two new members annually appointed to this committee. To carry out the work of the Committee on Monographs, the Academy has established a revolving fund of $1,000, which will be used to underwrite the publication of the first monographs. Receipts from the sale of monographs will be credited to this fund and used to finance the publication of future monographs. President CHAMBLISS has appointed the following to serve as the Committee on Monographs: for one year, FREDERICK D. ROSSINI, JOHN A. STEVENSON; for two years, ROLAND W. BROWN, EBEN H. TOOLE; for three years, HENRY B. COLLINS, JR. (chairman), EMMETT W. PRICE. Proposals from authors concerning the publication of such monographs should be sent to HENRY B. COLLINS, JR., Smithsonian Institution, Washington, D. C.

CUSTODIAN AND SUBSCRIPTION MANAGER OF PUBLICATIONS

On May 5, 1939, the Board of Managers of the Academy created the office of Custodian and Subscription Manager of Publications. This officer, appointed for a term of three years, shall handle correspondence with new subscribers and subscription agencies, shall have charge of all reserve stocks of the Academy's publications, shall inaugurate a program to increase the sale of back numbers and complete sets of the JOURNAL, shall fill orders for the purchase of back numbers and sets, shall maintain at all times a detailed inventory of reserve stocks of back literature, and shall submit to the Board of Managers at the end of each year a detailed account of his activities. President CHAMBLISS has appointed W. W. DIEHL, of the U. S. Bureau of Plant Industry, to this new office.

CHEMICAL SOCIETY

509TH MEETING

The 509th meeting and the annual dinner of the Society were held in the auditorium of the Cosmos Club on Thursday, March 9, 1939, with President KRACEK acting as toastmaster. Following the dinner, Past President N. L. DRAKE was introduced. He briefly reviewed the past history of the Hillebrand Prize Award, spoke of some of its objectives, and introduced the 1938 recipients. President KRACEK then presented the award in a brief and dignified ceremony to RALEIGH GILCHRIST and EDWARD WICHERS for their contribution entitled *A new system of analytical chemistry for the platinum metals*. The next speaker was Professor JAMES LEWIS HOWE, of Washington and Lee University, who spoke in a delightful manner of the early history of research in platinum metal chemistry in this country, leavening his remarks with many personal reminiscences. The two recipients were next introduced. EDWARD WICHERS spoke on *Glimpses of platinum metal chemistry*, outlining the basic problem, and the mode of attack that has led to its solution in the laboratories of the National Bureau of Standards. RALEIGH GILCHRIST gave *Reminiscences* of the research, which has, incidentally, led to the

production of platinum metals of known and controllable purity, for it is found that many of the analytical procedures, when employed on large scale lots, lead to the economical production of the pure metals in competition with the methods that formerly led to relatively impure products.

510TH MEETING

The 510th meeting was held in the auditorium of the Cosmos Club on Thursday, April 13, 1939, President KRACEK in the chair. After the reading of the minutes the Society was addressed by WARREN E. EMLEY, chief of the Organic and Fibrous Materials Division, National Bureau of Standards:

WARREN E. EMLEY: *Testing of plastics and the significance of the results.*—The variety of plastics commercially available is now very large. Manufacturers have sufficient control of their processes to vary the properties of their products within large limits. If a prospective consumer can tell the manufacturer just what properties he desires, he can probably find some manufacturer willing to undertake to make an article having those properties. Before this can be done, however, it is essential that accepted test methods be available. Otherwise the consumer will not be able to make his wants known in a manner intelligible to the manufacturer. The development of such test methods is now the major objective of the work of Committee D-20 on Plastics, of the American Society for Testing Materials. (*Author's abstract.*)

511TH MEETING

The 511th meeting was held at the University of Maryland, College Park, Md., on Thursday, May 11, 1939, President KRACEK presiding. The meeting was preceded by an informal dinner in the University Dining Hall. After the reading of the minutes the Society divided into three sections for the reading of papers.

Section of Analytical Chemistry, C. E. WHITE presiding:

A. KEITH BREWER: *The application of the mass spectrograph to the study of isotope abundance and atomic weights.*—Two types of mass spectrographs are in use at the present time. The Aston combined energy and momentum analyzer is used for accurate determinations of mass, and the Dempster 180° momentum analyzer for determinations of abundance ratios. Within the past few years mass spectrograph design and technique have been so simplified and perfected that high precision instruments can now be built at comparatively moderate cost.

The principal use of the mass spectrograph at the present time is for the determination of isotope abundance ratios. From such measurements on lead and uranium an estimate of the geological age of the rocks can be obtained, while from similar measurements on potassium and calcium, or rubidium and strontium minerals, the age of matter itself can be computed. Atomic weights of most of the elements can be determined directly from the abundance ratios; the accuracy is comparable with the best chemical technique for absolute weights and materially better for comparative values. Abundance measurements have shown that the atomic weights of several of the elements are not constant in nature but vary between appreciable limits. Very small quantities of material are needed in determining isotope abundance ratios. In the case of potassium, 10^{-4} gms of any potassium containing material is all that is required, while 10^{-10} gms of potassium can be detected; no chemical treatment is necessary.

New uses for the mass spectrograph are continually being found. Doubtless the most important application is in the analysis of biological tissues for natural isotopes used as "indicators" in metabolic studies. Recent developments of methods for concentrating isotopes and the phenomenal results that have been obtained bid fair to make the mass spectrograph a necessary instrument for the biochemist. The mass spectrograph has great possibilities in the field of analytical chemistry; this is especially true in the analyses of trace elements where extreme sensitivity is necessary. (*Author's abstract.*)

LOUIS L. MADSEN and RUSSELL E. DAVIS: *Studies on the determination of carotene and vitamin A in blood plasma with the spectrophotometer.*—Spectrophotometric examinations have been made on extracts containing the nonsaponifiable fraction of cattle blood plasma. Extracts from carotene determinations were made to volume in a mixture of equal parts absolute ethyl alcohol and a higher boiling petrolic ether (B. P. 90°–98° C) after being extracted according to the principle of the Willstätter and Stoll procedure. By definition, the material corresponding to the theoretical beta-carotene absorption measured at 430, 436, 450, and 480mμ is listed as carotene, while the nonsaponifiable material of blood plasma which was soluble in cold methyl alcohol and had a selective absorption maximum at 328mμ was called vitamin A. In general, extracts from blood plasma which are high in carotene and vitamin A give absorption characteristics more nearly equal to theoretical values than extracts from blood plasma from animals that are low or deficient in these factors. Methods for the preparation of extracts that are free from compounds causing interfering absorption have not been developed.

Data are presented on determinations made on the blood plasma of beef heifers fed normal and carotene-deficient rations and a relation between the carotene intake and the carotene and vitamin A content of the blood plasma was demonstrated. Uncorrected values are recorded showing the carotene content of the plasma of normal animals to be as high as 11.7 micrograms per cc, while the highest vitamin A value found was 0.58 microgram per cc. For deficient animals the lowest blood carotene recorded was 0.06 microgram per cc, while the lowest vitamin A value found was 0.03 microgram per cc. It appears that the degree of carotenemia depends upon the exogenous supply and storage of carotene and therefore varies within wide limits, while the vitamin A content of the plasma reaches a less variable physiological level, which it maintains as long as the supply of carotene or vitamin A is adequate but which also decreases in the state of deficiency. (*Authors' abstract.*)

GEORGE M. MACHWART and MARRIOTT W. BREDEKAMP: *Acidity in petroleum oils: Electrometric titration method.*—A study of acidity in an oxidized petroleum oil by electrometric titration has indicated that: (1) Rate of formation of acidity may be independent of the rate of formation of sludge; (2) the amount of acidity present was found to be greater with certain inhibitors present in the oil than in the absence of these inhibitors. The apparatus used was found to be very sensitive to external factors and several recommendations were made to minimize the effect of these factors. It is believed that the electrometric titration method for the determination of acidity may be valuable in the development of the mechanism of inhibition and deterioration of motor lubricants. (*Authors' abstract.*)

Section of Organic and Biological Chemistry, N. L. DRAKE presiding:

LEWIS W. BUTZ, ADAM M. GADDIS, and ELEANORE W. J. BUTZ: *The synthesis of substances related to steroids.*—The steroids that have been synthesized from simpler nonsteroid compounds have contained one or more benzenoid rings. Of the 70 or 80 steroids that have been found in nature, 6 con-

tain a benzenoid or naphthalenoid system; the others are alicyclic. We have studied some addition reactions of 1,3,5-hexatriene with a view to the development of synthetic methods for the preparation of the alicyclic type.

Hexatriene would be expected to add by a Diels-Alder reaction to unsaturated carbon-carbon bonds to give compounds containing a 3-vinylcyclohexene system. Although other types of addition can be foreseen, the Diels-Alder type occurs very generally with polyenes. If the 3-vinylcyclohexene derivative is formed, it will show a tendency to rearrange to isomers in which the two double bonds have become conjugated, although the experimental conditions under which such isomerization occurs have not been precisely determined. By migration of a single hydrogen atom, two secondary products can result, a 3-ethylidenecyclohexene and a 2-vinylcyclohexene. The latter is a reactive diene type and should add a mol of olefin to give a product which contains an 8-octalin system. The 3-ethylidenecyclohexene type has been found not to participate in the Diels-Alder reaction, but it might conceivably isomerize by migration of another hydrogen atom to an ethylcyclohexadiene which is a reactive diene type. It should therefore be possible, by supplying an active addend to the 3-vinylcyclohexene derivative, to diret isomerization preponderantly in the direction of formation of the 2-vinylcyclohexene and obtain in good yield a product which is essentially the result of the successive addition of two mols of olefin to hexatriene.

The synthetic route under investigation then consists of three steps:

I. hexatriene + olefin ⟶ 3-vinylcyclohexene

II. 3-vinylcyclohexene ⟶ 2-vinylcyclohexene

III. 2-vinylcyclohexene + olefin ⟶ 8-octalin

For the synthesis of a steroid the olefins in this, the shortest reaction series, must be a cyclopentene and a cyclohexene derivative. Other series consisting of addition of open chain compounds to a triene or dienyne system, followed by ring closure of the Diels-Alder or other type, may prove of greater practical importance.

Aside from one failure to add 1-methylcyclohexen-3-one to hexatriene, only one Diels-Alder addition to hexatriene has been reported. E. H. Farmer reported the synthesis of 6-ethylidene-1,2,3,6-tetrahydrophthalic anhydride from hexatriene and maleic anhydride at 100°. Since 6-vinyl-1,2,3,6-tetrahydrophthalic anhydride would be the expected product, isomerization was nearly complete. We have found, however, that by allowing hexatriene and maleic anhydride to react at 30°, a quite different adduct is obtained which is isomeric with Farmer's ethylidene-anhydride.

Naptho-1,4-quinone and hexatriene at 50° gave two products, a liquid and a solid. Present evidence indicates that the liquid is the expected vinyltetrahydroanthraquinone, that the solid is the ethylidenetetrahydroanthraquinone or ethyldihydroanthraquinone. Hexatriene and 4-acetoxylo-2,5-quinone gave two solid isomers of the expected empirical constitution. Hexatriene and *p*-xylo-2,5-quinone gave a liquid 1:1 adduct and a mixture of solid products from which a fraction with the composition of an adduct of one mol hexatriene with two mols xyloquinone was obtained. A similar product was obtained from the 1:1 adduct by heating with xyloquinone. In contrast to the other solid adducts reported here, which were crystalline, this interesting fraction from xyloquinone appeared to be amorphous and individual batches melted at different temperatures. Cyclopentene-1-aldehyde and 1-methylcyclopenten-5-one gave liquid adducts of the expected composition (hydroindenes) with hexatriene. (*Authors' abstract.*)

M. HARRIS and A. SOOKNE: *Electrophoresis studies of fiber (protein and cellulose) surfaces.*—No abstract available.

R. M. HANN, W. D. MACLAY, and C. S. HUDSON: *The structure of diacetone dulcitols.*—It is shown that the properties of the α- and β-diacetone dulcitols, as well as those of several new derivatives of these substances, exclude the possibility that they can be enantiomorphic substances and prove that they are structural isomers. Evidence has been obtained from periodate and lead tetraacetate oxidations that neither α- nor β-diacetone dulcitol contains a glycol grouping. The results of a study of the ditosyl, di-iodo, and ditrityl derivatives of β-diacetone dulcitol indicate that it contains two free prinary hydroxyl groups, and a study of the oxidation of the diacyl dulcitols, derivable from it, proves that its structure is that of 2,3,4,5-diacetone dulcitol. The results of a study of the ditosyl, monotosyl monoiodo, and monotrityl monoacetyl derivatives of α-diacetone dulcitol indicate that it contains one free primary hydroxyl group and one free secondary hydroxyl group, and a study of the oxidation of the dibenzoyl dulcitol derived from it proves that it is 2,3,5,6-diacetone-*D,L*-galactitol. An acyl migration by which 1:4-dibenzoyl-*D,L*-galactitol (a racemic form) passes to 1:6 dibenzoyl dulcitol (a meso form) has been demonstrated.

A cyclic acetal shift has been shown to be the cause of the interesting and unusual changes which Fischer and Bergmann noticed upon acetylation of α-diacetone dulcitol. The shift occurs as a stage in the benzoylation of α-diacetone dulcitol with benzoyl chloride and quinoline or pyridine at elevated temperatures. In structural terms it is represented as the passage of 1:4-dibenzoyl-2,3,5,6-diacetone-*D,L*-galactitol to 1:6-dibenzoyl-2,3,4,5-diacetone dulcitol. (*Authors' abstract.*)

Section of Physical Chemistry, M. M. HARING presiding:

R. E. GIBSON and O. H. LOEFFLER: *The effect of pressure and temperature on the absorption of light by solutions of aromatic amines in nitrobenzene.*—No abstract available.

J. F. SCHAIRER: *The chemical composition of the rock-forming pyroxenes.*—The rock-forming pyroxenes constitute one of the most important mineral groups of the igneous rocks. They present exceptional complexity both of crystalline modifications and chemical composition, and are a series of solid solutions, some of the molecules of which are completely miscible and others only partly miscible. The important chemical molecules that enter into the composition of the rock-forming pyroxenes are: $CaSiO_3$, wollastonite, pseudowollastonite; $MgSiO_3$, enstatite, clinoenstatite; $CaSiO_3 \cdot MgSiO_3$, diopside; $FeSiO_3$, ferrosilite, clinoferrosilite; $CaSiO_3 \cdot FeSiO_3$, hedenbergite; $MnSiO_3$, rhodonite, bustamite; $CaSiO_3 \cdot MnSiO_3$, johannsenite; molecules containing Al_2O_3, augites; Fe_2O_3, augites and babingtonite; TiO_2, titaniferous augites; $Na_2O \cdot Al_2O_3 \cdot 4SiO_2$, jadeite; $Na_2O \cdot Fe_2O_3 \cdot 4SiO_2$, acmite, aegirite.

The three most important molecules are the metasilicates $CaSiO_3$, $MgSiO_3$ and $FeSiO_3$. Data for the stability relations between $CaSiO_3$—$FeSiO_3$ and $MgSiO_3$—$FeSiO_3$ have been given by Bowen and Schairer in papers on the systems CaO—FeO—SiO_2 and MgO—FeO—SiO_2, respectively. The relations between diopside ($CaMgSi_2O_6$) and $MgSiO_3$ are given by Bowen and Andersen in their paper on the system forsterite—diopside—silica. Data are presented here for the binary system $CaSiO_3$—diopside ($CaMgSi_2O_6$). In order to find the stability relations of the pyroxenes containing Al_2O_3, it will be necessary to study two quaternary systems: CaO—FeO—Al_2O_3—SiO_2 and MgO—FeO—Al_2O_3—SiO_2. The first of these is in progress and complete data for the ternary system, FeO—Al_2O_3—SiO_2, are presented. The incongru-

ent nature of the melting of acmite ($Na_2O \cdot Fe_2O_3 \cdot 4SiO_2$) and complete melting relations for this mineral have been given by Bowen, Schairer, and Willems in their paper on the system Na_2SiO_3—Fe_2O_3—SiO_2. Data are at hand showing that jadeite ($Na_2O \cdot Al_2O_3 \cdot 4SiO_2$) near liquidus temperatures breaks down into nepheline and albite. (*Author's abstract.*)

WALTER J. HAMER: *Variation of hydrogen-ion concentration with temperature.*—Although considerable information is available on the variation of ionization constants with temperature, little is known of the variation in hydrogen-ion activity or "active acidity" with temperature. In order to learn whether the variations of "active acidity" are similar to the variations in ionization constants and whether there is a general relationship between hydrogen-ion activity and temperature, measurements were made at 5° C intervals from 0° C to 60° C of the pH values of different types of solutions by means of galvanic cells without liquid junctions, using hydrogen and silver-silver chloride electrodes. This method of measuring the acidity is independent of Soret effects and liquid junction errors, common to the usual electrometric method of measuring acidity. The solutions studied were potassium acid phthalate, sodium acid malonate-sodium malonate, sulfamic acid, boric acid-potassium hydroxide, glycine-hydrochloric acid, glycine-sodium hydroxide, hydrochloric acid, and potassium hydroxide. From the pH data obtained for these solutions, it was observed that with an increase in temperature the pH values of alkalies decrease, the pH values of strong acids increase and that the pH values of weak acids exhibit a minimum in the pH-temperature curve, the minimum occurring at different temperatures for different pH values. The degree of change in pH with temperature is smaller the closer the pH is to neutrality. It was also observed that the changes are independent of the concentration of the solution but depend slightly upon the valencies of the ions in the solutions. The difference in the variations of alkaline and acid solutions with temperature may possibly be explained by the differences in the apparent partial molal volumes of alkalies and acids and by the differences in the variation of this quantity with temperature and by the large change in the pH of water with temperature. It was also observed that the variations are different for ampholytes such as amino acids than for other types of solutions. They exhibit smaller changes in the acid range and larger changes in the alkaline range than the other types of solutions. This may be explained by the fact that the entropy of ionization of amino acids is about half that for other acids and bases and by the fact that the charges on ampholytes are widely separated, giving rise to a strong electrostatic field. (*Author's abstract.*) RAYMOND M. HANN, *Secretary.*

BOTANICAL SOCIETY

292D MEETING

The 292d regular meeting was held in the assembly hall of the Cosmos Club, November 1, 1938, President GRAVATT presiding; attendance 85. GEORGE E. HALLIDAY was elected to membership.

Notes and reviews.—WILLIAM A. DAYTON called attention to a monograph on lupines being prepared by Charles Piper Smith of Saratoga, Calif., for which subscriptions would be welcome. Hugo Glück of the University of Heidelberg has made a request for specimens of *Micranthemum nuttallii*, an aquatic plant. ROBERT COOK called attention to the fact that some patents had been issued recently on chemicals for growth of roots to the Boyce Thompson Institute.

Program.—HOWARD W. JOHNSON: *Mycological and pathological observations on Crotalaria.* *Crotalaria*, a new summer cover and green manure crop, is proving to be especially well suited to the sandy lands of the South. Two species, *C. striata* and *C. spectabilis*, already have become of agricultural importance. In plantings made to date these species have been found immune from nematodes. This fact is of great economic importance in connection with any crop throughout the South. However, diseases are already proving a factor in the growth of *Crotalaria* in the United States and in this paper attention is called to three diseases attacking the crop at Arlington Experiment Farm, Arlington, Va. These are: (1) powdery mildew (*Microsphaera diffusa*), (2) gray mold (*Botrytis cinerea*) and (3) mosaic (virus). Perithecia of the powdery mildew develop on *Crotalaria* species in both field and greenhouse at Arlington Farm. This is apparently the first report of perithecia of *Microsphaera diffusa* on this host in the Western Hemisphere and confirms earlier records of this powdery mildew on *Crotalaria* from Puerto Rico, where identification was based on the oidial stage only. The mosaic on *Crotalaria* causes dwarfing and mottling of the leaves and extreme proliferation of lateral buds (witch's brooming) on some species. The virus is readily transmissible mechanically to horsebean (*Vicia faba*), red clover (*Trifolium pratense*), crimson clover (*Trifolium incarnatum*), garden peas (*Pisum sativum*), and field pea (*Pisum arvense*). It apparently does not attack garden bean (*Phaseolus vulgaris*), soybean (*Soja max*), alfalfa (*Medicago sativa*), cowpea (*Vigna sinensis*), or *Petunia hybrida*. Host range and property studies completed to date show this virus to be similar in many respects to the known strains of pea mosaic but it differs in other respects and further work is necessary to determine whether it shall be described as a strain of pea mosaic or as a distinct entity to be known as *Crotalaria* mosaic.

E. D. MCALLISTER: *New facts in photosynthesis.* Experimental evidence was presented indicating the formation, during the actual process of photosynthesis, of a material in relatively large quantities which combines with or absorbs carbon dioxide. The experiments establishing the existence of this carbon-dioxide-combining intermediate are entirely new in type, and the intermediate bears no evident relationship with any plant material previously described as combining with carbon dioxide, being produced, as it is, only during the actual process of photosynthesis, and apparently surviving thereafter for a short time. Its presence during photosynthesis can be measured by a "pick-up" of carbon dioxide in darkness immediately following a high rate of photosynthesis. That chlorophyll is intimately related to or associated with this intermediate is suggested by a simple stoichiometry of the order of unity that is found to exist between the number of carbon dioxide molecules taken up and the total number of chlorophyll molecules present in the plant.

ALICE M. ANDERSEN, *Secretary.*

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